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Review

Oily politics: A critical assessment of the oil and gas industry's contribution to climate change

Marco Grasso

Università degli Studi di Milano-Bicocca, Dipartimento di Sociologia e Ricerca Sociale, Via Bicocca degli Arcimboldi, 8, 20126, Milan, Italy

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ABSTRACT

The article investigates the role the oil and gas industry has played in climate change. Two-thirds of global industrial greenhouse gas emissions over the past two centuries can be traced to the activities of a handful of companies, most of which belong to this industry. Emissions generated by oil and gas companies' products and processes have significantly increased the concentration of greenhouse gases in the atmosphere. To add to this, some of the oil and gas majors have funded, shaped, and advanced climate denial. Through this behaviour, these companies have besmirched the entire industry and substantially contributed to paralysing global climate policy for decades. In brief, the oil and gas industry has – either directly through emissions or indirectly through denial – played a major role in anthropogenic climate change, the impacts of which are causing serious harm to humanity and the planet. This article carries out a review of the relevant literature in order to explore and justify this claim, as well as to lay the groundwork for analysing the consequent moral and political implications. It opens by overviewing the oil and gas industry, before going on to focus on the contentious and inconsistent process that led oil and gas companies to – grudgingly, and in a limited fashion – acknowledge climate change, a vivid testament to their awkward coexistence. Thereafter, the article turns its attention to the oil and gas companies' direct contribution to global greenhouse gas emissions; and finally on how their efforts to upend accepted climate science through denial has been a powerful indirect contributing factor to climate change.

1. Introduction

Almost 30 years ago, awareness of climate change rocketed into the public sphere, following the publication of the 1990 First Assessment Report of the Intergovernmental Panel on Climate Change (IPCC); at the time, over 80% of the world's energy came from fossil fuels, and this share has remained largely unchanged since then. Fast forward to this day: global emissions rose globally by around 2% in 2017, despite the encouraging slowdown of the previous three years [1]. While this downtrend is usually explained by the global economic recession, the growth in low/zero carbon energy, greater energy efficiency (especially of internal combustion engines), and a switch from coal to gas in power plants, fossil fuels remain the driving force of the world's socio-economic systems.

Oil and gas – the fossil fuels processed by the industry considered in this article – have given rise to a colossal business [2]: they are explored, produced, refined, and distributed throughout the globe by a host of industrial giants. These companies, through the emissions generated by their products and processes, have significantly added to the increase of the concentration of greenhouse gases (GHGs), especially carbon dioxide and methane, in the atmosphere [3]. The relationship between emissions, concentrations, and climate change is well established in the pertinent scientific literature [3,4], and science almost unanimously [5,6] affirms that climate change is directly and profoundly harming the planet [3,7] and humanity [8]. Moreover, some major oil and gas companies have spared no expenses in oiling the climate change denial machine through funding and lobbying [9].

It is possible therefore to surmise that the oil and gas industry has been a key contributor – directly through emissions and indirectly through denial – to anthropogenic climate change and the related harm.

Society and policy makers are beginning to sit up and take notice. The role and responsibilities of oil and gas companies in climate change is a rapidly growing global concern that is provoking broad societal and political engagement, substantially weakening the industry's influence and putting the entire oil world under pressure [10]. Campaigns for divesting from fossil fuels, for instance, are proliferating worldwide [11]; similarly, initiatives to coerce fossil fuel companies to keep their reserves underground are multiplying; the 'keep it in the ground' movement even seems to be backed by the Pope [12]; investigative journalism is shedding light on the least accessible corners of the oil

E-mail address: marco.grasso@unimib.it.

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world;[1] oil and gas companies are increasingly targeted by shareholder climate resolutions [13] and lawsuits [14]. Such issues, while extensively considered as background references for the ensuing arguments, are not thoroughly examined because of space constraints.

The objective of the article is rather to investigate the oil and gas industry's prominent role in the current climate crisis deriving from its dealing in such harmful products. To this end, the article carries out a narrative review in order to provide an exploratory evaluation [15] of the scientific and non-scientific literature on the relevance of oil and gas companies' contribution to both global GHG and to climate denial. This article has been prompted by the lack of rigorous, comprehensive reviews able to provide the reference framework necessary for starting to reconsider the future of the oil and gas business in a climate shaken world. Indeed, this review strives to lay the groundwork for analysing the consequent moral and political implications for oil and gas companies and for climate policy.

The material considered in the review includes i) scientific peer-reviewed articles, books, and reports; ii) non-scientific pieces published in respected newspapers and magazines, and by news agencies (e.g. *The Guardian*, *The New Yorker, Reuters*); and iii) other reliable non-scientific sources (e.g. independent research and policy institutes like *Chatham House*, investigative journalism outlets such as *InsideClimate News*, influential non-governmental science advocacy organisations working on climate issues, such as the *Union of Concerned Scientists*). Reference materials have been sourced from the last thirty years of publications, with non-scientific ones (ii and iii) naturally having more recent publication dates, given the nature of the source, the growing interest and the consequent wealth of emerging material, the ever-changing features of the issues at stake, as well as their increasing relevance. The main rationale for the selection of sources was their authoritativeness; also paramount were their independence, reliability, and rigour, in a context where bogus science and fake news flourish, as illustrated in the section on denial. This choice, however, has an inevitable drawback: given the almost unanimous consensus of the scientific community on anthropogenic climate change [5,6], which also informs the non-scientific sources used – and, in fact, concurs in making them authoritative in this context – the article at first sight might seem biased toward the – so to speak – orthodox and politically correct narrative of climate change. But a nonpartisan even-handedness is attempted throughout: it is written as objectively as possible by trying to include a representative account of all the nuanced arguments raised by the various sources regarding the oil and gas companies' extensive and controversial role in climate change.

Before proceeding, some specifications are necessary. The article refers to the 'oil and gas (or sometimes only the 'oil') industry'. This is meant to refer to 'the major oil and gas companies', or, more precisely, despite the many terminological disputes within the oil world, those large multinational companies that engage in the exploration, production, refinement, and distribution of hydrocarbons, i.e. 'conventional oil' 'unconventional oil', and 'unconventional liquids'.[2] Conventional oil is the most easily accessible family of hydrocarbons and, despite a recent decline in discoveries [16], it accounts for the greatest share of global liquid fuels, and will likely still account for around 90% in 2030 [17]: it basically includes crude oil, condensate, and natural gas liquids. Unconventional oil refers to less accessible resources that require, as the name suggests, 'unconventional' techniques: it includes extra heavy oil, oil shale, oil sands, and tight oil. Extraction of this kind of oil is, for instance, currently thriving in the West Texas Permian basin; this is expected to unsettle global oil production and the geopolitics of energy [18]. Finally, unconventional liquids are those liquid hydrocarbons produced synthetically, such as coal-to-liquids, gas-to-liquids, and biofuels [19,20].

It should also be specified that the coal industry, despite its substantial contribution in terms of GHG emissions ([21]: Table 4, 17) and its active involvement in the climate change denial campaign [9], is not considered in this article. It has, in fact, played a lesser role in both domains compared to the oil and gas industry. However, the fundamental reason for its exclusion is not only a – so to speak – quantitative one. Rather, it is mostly due to the fact that the coal industry is already undergoing an irreversible decline as a result of intrinsic cost issues. In spite of the recent distortionary coal subsidisation [22] and pro-coal policies [23], in the United States among others, technology has considerably reduced the cost of competing sources of energy – like natural gas and certain kinds of renewables – making them more competitive than coal [24]. Even in China, whose astonishing economic growth in the last forty years has been chiefly propelled by coal, the use of this fossil fuel has already peaked [25]. Hence, the exclusive focus of this article on the oil and gas industry is consistent with its aim to provide an empirical frame for understanding the role of an industry whose very nature poses such a threat to the climate system, and whose modus operandi does not seem set to change in the near future.

In accordance with these considerations, methodological clarifications, and specifications, the article develops as follows: it first provides an overview of the oil and gas industry; it goes on to analyse the oil industry's acknowledgement of climate change and their coexistence. Thereafter, the article explores oil and gas companies' direct contribution to global GHG emission. It closes by focusing on how some of these companies chose to muddy the factual waters by promoting climate denial, an indirect contribution to climate change.

2. The structure of the oil and gas industry

'Oil' is a comprehensive term that covers the organic liquid hydrocarbons resulting from the different combinations of carbon and hydrogen atoms. The amount of energy released in oil combustion processes and the almost infinite forms in which hydrocarbon molecules can be recombined into petrochemical materials possibly make oil the world's most important resource. Oil is ubiquitous: it is used for countless products – computers and smartphones, toothpaste and lipstick, medicines and fertilisers, artificial hearts and diapers – and it is the global economy's primary energy and fuel source. Despite its crucial role in our lives today, the oil economy only started in earnest around the end of the nineteenth century, mostly thanks to the entrepreneurial, if sometimes ruthless, genius of John D. Rockefeller, when briskly rising sales of automobiles began creating a huge demand for gasoline, driving oil companies to search for more oil fields. Rockefeller's Standard Oil Company rapidly gained control of 90% of America's refining capacity, and most of its pipelines and gathering systems. Only Royal Dutch Shell, in Europe, could to some degree rival its wealth and power [26]. The history of the modern oil and gas industry is, however, one of radical shifts in control and dominance, and it has always been strictly intertwined with world politics. This section briefly outlines the evolution of the last thirty years or so of the oil and gas industry, indicatively since the first IPCC report in 1990, and the related uncontroversial acknowledgement that human activities were affecting the climate, even if there is strong evidence that the major oil and gas companies knew the science of climate change and its potential impacts from the late 1950s onwards, as described below. The late 1980s was also the time when the current structure of the oil industry, basically made up of privately-owned International Oil Companies (IOCs) and state-owned National Oil Companies (NOCs), took shape, even if over the years the relevance and power of the latter group have significantly increased [27,28].

[1] For instance, the Climate Investigation Center, DeSmog, and the Pulitzer prize-winning InsideClimate News.

[2] This analysis excludes two other types of oil and gas companies, given their irrelevance in terms of contribution to global GHG emissions and to climate denial: the so called 'independents', smaller companies that generally operate only in the upstream segment of the oil industry's operations; and 'oilfield service companies', which provide services and outsourcing options to the oil industry.

The processes and systems involved in extracting, producing, refining, and distributing oil and gas are highly complex and capital-intensive, and they require state-of-the-art technology. This is because the oil and gas industry performs what could be considered a modern miracle: it undoes in a very short span of time – typically from two to four weeks – what took nature up to 200 million years to do, i.e. it returns the carbon atoms of the hydrocarbon molecules, originating from marine and land organisms, trapped underground in sand and rock, to the surface, ultimately ending up as carbon dioxide emissions and other harmful pollutants in the atmosphere. Moreover, given the discrepancy between the localisation of oil reserves and demand, the same miracle also performs a spatial redistribution of released carbon atoms, meaning they eventually accumulate in the atmospheric global commons. In other words, the oil industry is a gigantic time and space carbon conveyor-belt, transporting carbon stocks from a distant geological era embedded in the Earth into the present-day global atmosphere [28].

Usually, oil is owned by states or, in weak and failed ones, by the subjects who exert irregular coercive control over them [29]. But the oil industry is the machinery that moves oil from below the ground, regardless of its ownership and localisation, to the global economy. The activities of the oil and gas industry are divided into upstream operations of exploration and production, and downstream operations of refining and distribution. Given the high entry costs, the world's major oil and gas companies are typically integrated, i.e. they carry out both upstream and downstream activities. Exploration includes prospecting and seismic and drilling activities that take place before the development of a proper oil field; production involves the extraction of oil from below the ground via onshore and offshore drilling; refining concerns the separation of unwanted components in order to obtain clean hydrocarbons that are then channelled to produce different goods and services; finally, in the distribution phase, these products are transferred where demand requires, through pipeline networks, tankers, railway tanks, and trucks.

This complex, multifaceted, painstaking, but in the end hugely profitable work – the global oil and gas industry has roughly $2 trillion of annual revenues [30] – is largely carried out by a handful of IOCs and NOCs, since this industry is extremely concentrated [2]. As said, IOCs are private entities whose business operations traditionally cover the full cycle from exploration, through production and refinement, to distribution of petroleum products. NOCs are by and large similarly structured, but they are fully or largely owned by a state. Traditionally, IOCs were understood as 'resource seeking' to supply their downstream activities of refinement and distribution; NOCs were instead considered 'market seeking' since they were supposed to look for new markets to distribute their products. This distinction is no longer tenable, however, for a number of concurrent reasons. First, NOCs no longer operate on the basis of a national political logic; rather, they are equally driven by commercial goals; IOCs and NOCs increasingly cooperate globally in developing more challenging oil fields; some NOCs, especially from Asia, are active 'resource seekers', in upstream competition with IOCs, since their countries of origin do not have oil reserves; the shrinking European and North American oil markets push IOCs to engage in 'market-seeking' activities ([28]: 29–30).

The largest IOCs – e.g. ExxonMobil, Shell, BP, Chevron, Total (see Table 2) – are international, vertically integrated firms, generally based in the United States and Europe, with extracting and distribution operations worldwide. IOCs reigned supreme in the oil world until the 1970s, thanks to the long-term concession agreements dating back to the colonial era and maintained in the immediate years after decolonisation, also given host countries' lack of the technical competence necessary to explore and produce oil and gas. IOCs' supremacy was gradually eroded by the growing role of state-owned NOCs, established by and headquartered in the major exporting countries, which in the 1970s concluded the process started some two decades earlier, of taking control of their own oil and gas reserves [28]. The primary principle that led to the creation of NOCs in post-colonial states was that of permanent national sovereignty over natural resources, sanctioned in many United Nations declarations, resolutions, and treaties. NOCs, thanks to their ownership of reserves, have developed extensive vertically integrated global networks of distribution of oil products. NOCs currently include the biggest oil companies in the world (see Tables 3 and 4): Chinese PetroChina, Russian Gazprom, National Iranian Oil, and Saudi Arabian Aramco – the world's biggest, with a 10% share of crude oil – are among the largest ones in terms of production. In fact, NOCs are not a homogenous group [27]; a useful distinction is between those belonging to countries that hold large amounts of reserves and are oil exporters, and those based in oil-importing countries, typically in Asia. In oil-exporting countries, NOCs were founded as a political response to the perceived traditional exploitation of their oil reserves by IOCs. This process, which started in 1938 with Mexican Pemex, culminated in the 1970s when most Middle Eastern countries, as well as some Western ones – Canada, Norway, the United Kingdom – spurred by strong increases in oil prices, established their NOCs. On the other hand, oil-poor Asian countries – China, India, South Korea – established their NOCs in the 1980s/90s, with the objective of targeting international resources, purchasing new properties, and participating in other oil companies.

Given their size and increasing dominance over global reserves – currently NOCs control roughly 90% of the world's oil and gas reserves, while in 1970 they had access to only 1% of such reserves (and IOCs still to 85%) ([27]: 6) – their 75% share of global oil production, as well as their control of most infrastructures [33,34], NOCs' importance in comparison to IOCs' has significantly risen [28], as evinced also by Tables 1–4.

3. The oil and gas industry and climate change: acknowledgment and coexistence

A recent study [35] that investigates the position on climate change of eight major fossil fuel companies, including five oil and gas IOCs (BP, Chevron, ConocoPhillips, ExxonMobil, and Shell), based on their January 2015 to May 2016 communications, documents, and actions, shows that the relation between the oil and gas industry and climate change is still an extraordinarily awkward and controversial one. For instance, while all the oil and gas companies analysed openly acknowledge climate science and plan for a less carbon-intensive business, they at the same time 'maintain membership – and in many cases have leadership positions – in trade associations and other industry-affiliated groups that spread disinformation about climate science and/or seek to block climate action' ([35]: 2). Or, to put a specific IOC under the microscope, it took Shell more than 16 years to caution its shareholders that climate policy represented a financial risk for the company, despite having privately known for decades about the causality relation between its products and climate change [36]; at the same time, rather

Table 1
Largest National Oil Companies' Ownership.
Source: Companies' websites; [31,32].

NOC	Ownership	Total Assets (US$ Billion)
Abu Dhabi National Oil	UAE government (100%)	n.a.
China National Petroleum	Chinese government (100%)	585.6
Gazprom (Russia)	Russian government (50.23%)	277.3
Kuwait Petroleum	Kuwaiti government (60%)	n.a.
National Iranian Oil	Iranian government (100%)	200.0
PDVSA (Venezuela)	Venezuelan government (100%)	226.8
Pemex (Mexico)	Mexican government (100%)	113.1
Petrobras (Brazil)	Brazilian government (64%)	247.0
Saudi Aramco	Saudi Arabian government (100%)	n.a.
Sinopec (China)	Chinese government (100%)	310.7

Table 2
Oil and gas companies by revenues, 2016 (US$ million).
Source: Data taken from [32].

Oil and gas company	Revenues	Typology
Sinopec (China)	267,518	NOC
China National Petroleum	262,573	NOC
Royal Dutch Shell (United Kingdom /Netherlands)	240,033	IOC
ExxonMobil (United States)	205,004	IOC
BP (United Kingdom)	186,606	IOC
Total (France)	127,925	IOC
Chevron (United States)	107,567	IOC
Gazprom (Russia)	91,382	NOC
Petrobras (Brazil)	81,405	NOC
Lukoil (Russia)	70,897	IOC

Table 3
Oil and gas companies by production, 2015 (million barrels oil equivalent per day).
Source: [27]: Table 2.1, 45–46.

Oil and gas company	Production	Typology
Saudi Aramco	12	NOC
Gazprom (Russia)	8.3	NOC
National Iranian Oil	6	NOC
ExxonMobil (United States)	4.7	IOC
Rosneft (Russia)	4.7	NOC
PetroChina	4	NOC
BP (United Kingdom)	3.7	IOC
Royal Dutch Shell (United Kingdom/Netherlands)	3.7	IOC
Pemex (Mezico)	3.6	NOC
Kuwait Petroleum	3.4	NOC

Table 4
Oil and gas companies by reserves, 2015 (million barrels oil equivalent).
Source: [27]: Table 2.1, 45–46.

Oil and gas company	Production	Typology
PDVSA (Venezuela)	298	NOC
Saudi Aramco	260	NOC
National Iranian Oil	156	NOC
Abu Dhabi National Oil	137	NOC
Kuwait Petroleum	111	NOC
Rosneft (Russia)	34	NOC
Pemex (Mexico)	31	NOC
ExxonMobil (United States)	13	IOC
China National Petroleum /PetroChina	11	NOC
Petrobras (Brazil)	11	NOC

surprisingly, Shell is lobbying the United Sates Congress to introduce a carbon tax [37]. In the meantime, the Texan oil industry is expecting government-funded seawalls to protect its refineries in the Gulf of Mexico from the more powerful storms and higher tides expected from climate change [38].

The coexistence between the oil and gas industry and climate change has, in fact, been challenging since the beginning. This industry has often displayed a duplicitous 'two-faced' behaviour towards climate change [39]. Some serious science took place in the research facilities of the oil and gas companies, which led them to conclude that climate change was real and dangerous. Nonetheless, they funded bogus science and think tanks to spread denial and doubt about the same evidence that their own scientists had produced [40].

It is usually assumed, as already stressed, that man-made climate change became part of the wider public discourse after the 1990 First Assessment Report of the IPCC. A more prudent benchmark of awareness can be set at 1992: in that year, during the Rio Conference, heads of state and delegates were officially informed about a global scientific consensus on the harmful effects of GHG emissions (presented in a supplementary assessment report of the IPCC). Since that point in time, ignorance about the consequences of emissions and the alleged impotence of oil and gas companies to reduce their contribution has become inexcusable.

In truth, the oil industry had discovered the nexus between their produce and climate change decades previously. Scientists of Humble Oil (which was later absorbed into Standard Oil and eventually evolved into ExxonMobil) published research acknowledging the science of climate change in peer-reviewed journals as early as 1957. The renowned physicist Edward Teller, in a 1959 speech for the 100th birthday of the oil industry in America, organised by the American Petroleum Institute in New York, warned oil company executives, government officials, and scientists with startling prescience about the correlation between carbon dioxide and global warming [41]. In 1968, the Stanford Research Institute presented a report [42] to the American Petroleum Institute that 'warned the oil industry explicitly and in strong terms that the science underlying climate change was sound, that fossil fuel combustion provided the best explanation for climate change, that the impacts of climate change could be potentially significant on a global scale, and that the industry's highest research priority should be identifying means and technologies for reducing emissions' ([43]: 21). From 1968 onwards, these warnings were reiterated to the oil industry, even in dire terms [43]. In Europe, Shell knew too: in internal documents circulated in the 1980s, the company acknowledged the seriousness of climate change and stated that its products were responsible for it [44].

At any rate, at the 'dawn' of climate policy in the early 1990s, IOCs collectively refused to modify their business model in order to mitigate global warming, in some cases viewing the mounting pressure for curbing GHG emissions as a conspiracy aimed at disrupting the industry and the entire business world status quo [45]. The majority of NOCs, on the other hand, shielded by more protective governments and not subjected to public criticism or opinions that were either stifled or indifferent, seemingly ignored climate change until a few years ago, when some of them (CNPC, Pemex, Petrobras, Statoil, Saudi Aramco) eventually joined the 'Oil and Gas Climate Initiative', a voluntary alliance focused on leading the oil industry response to climate change.

The basic reasoning behind IOCs' position was that any kind of limit on emissions would directly threaten their revenues and profits, as well as raise the production cost for the many industries dependent on hydrocarbons [46]. To defend their business model, the major IOCs – Amoco, BP, Chevron, Exxon, Mobil (since 1999, merged into ExxonMobil), Shell, Texaco – used the 'Global Climate Coalition', an advocacy group of businesses put together with the help of public relations giant Burson-Marsteller in 1989, just one year after the first IPCC report, to promote climate denial, as explained in the later section on this issue. Through the Global Climate Coalition, the biggest IOCs cast doubt on the science of climate change and opposed policies against emission cuts. In 1996, BP left the Global Climate Coalition; the following year it publicly broke ranks with its still obstinately sceptical American peers and called for a precautionary approach to climate change;[3] shortly afterwards it was followed by Shell. This opened a period of an 'Atlantic divide' between major IOCs, and in particular between ExxonMobil and BP, as vividly illustrated by Lovell ([48]: 42–66) on reporting a 2003 debate between Frank Sprow and Greg Coleman, senior representatives from ExxonMobil and BP on environmental matters. The responses of the major IOCs across the Atlantic were surprisingly different until approximately the first few years of the third millennium. In brief, American companies Chevron and, in particular, ExxonMobil stood firm in their denial of anthropogenic climate

[3] This was made evident by the BP CEO John Browne's 1997 speech given at Stanford University [47]. In this speech Browne acknowledged the connection between GHG emissions and climate change and pledged that BP would help tackle the problem by shifting to a less carbon-intensive business model.

change, proclaiming the ruinous cost of GHG control, as they simultaneously lobbied against climate policy and invested very little in alternative sources.[4] European BP and Shell, on the contrary, accepted the scientific basis of anthropogenic climate change and espoused the principle of precautionary action, supporting the Kyoto Protocol and announcing substantial investments in renewables [50–52]. Powerful corporations, especially those in the oil industry, have the capacity and the influence to shape environmental policy, as opposed to merely voicing support or opposition [53], but in this instance, American IOCs adopted a markedly reactive stance based on the rebuttal of responsibility for climate change, while their European counterparts embraced a proactive strategy that accepted some measure of responsibility [52]. ExxonMobil's acknowledgment of climate change was, for instance, a particularly long and inconsistent process. It was prompted, paradoxically, by the descendants of John D. Rockefeller, the founder of Standard Oil, who from 2004 pushed the company, through letters, meetings, and shareholder resolutions, to acknowledge climate change, to abandon climate denial, and to take steps in the direction of clean energy [54]. In 2007, the company disclosed to shareholders, albeit in somewhat ambiguous language, the financial risks to profitability of climate change, all the while continuing to fund climate denial; a 2008 report presented to shareholders at the annual general meeting pledged to stop funding denial [55]. Only in April 2014, did ExxonMobil publish a report publicly acknowledging climate change for the first time [56]. Unsurprisingly, however, a recent study by Supran and Oreskes [57] found that until 2014 ExxonMobil had systematically misled the public about climate change. The study basically argued that while ExxonMobil's peer-reviewed scientific publications acknowledged the scientific consensus on climate change, internal documents and paid editorial-style advertisements ('advertorials') denied it. The more the latter group of documents were publicly accessible, the more they were impregnated by scepticism. Private correspondence acknowledged the scientific consensus, whereas openly available statements espoused climate denial: 'We find that as documents become more publicly accessible, they increasingly communicate doubt' ([57]: 1), highlighting those advertisements as being particularly effective in that regard. Ironically, ExxonMobil produced valuable climate science: '83 percent of peer-reviewed papers and 80 percent of internal documents acknowledge that climate change is real and human-caused'; but on the other hand when it went public 'only 12 percent of advertorials do so, with 81 percent instead expressing doubt' ([57]: 1).

Nowadays things seem to have changed, at least in terms of attitudes and intentions. All the largest IOCs have recognised anthropogenic climate change and started to aim at a low-carbon future. Even ExxonMobil, possibly the most obstinate climate opponent, states that the Paris Agreement is 'an important step forward by world governments in addressing the serious risks of climate change', and concedes that 'the company has a constructive role to play in developing solutions' [58]. Words, however, need to be transformed into action, and as carefully testified by Supran and Oreskes [57], ExxonMobil's approach to climate change remains highly ambiguous. Similarly, other IOCs still need to account for some lack of clarity in their conduct.

In any event, oil and gas companies envisage different courses of action for a low-carbon future, from investing in renewables, to modifying their business models in such a way that would see them not exploiting all the oil and gas reserves they hold. The rationale for the oil industry's willingness to change its behaviour might just be a sheer will to survive: if oil and gas companies want to keep their social license to operate [59] in a climate endangered world, they must behave and operate consistently in accordance with the mounting pressure and an emergent social norm towards the delegitimisation of carbon-intensive lifestyles, as was the case with other socio-economic practices which were once deeply entrenched and influential, like slavery [60] or tobacco [61]. Other circumstances exist – ones less rooted in moral reasoning – that could advance the cause of decarbonising the oil industry: first, the significant growth in recent years of renewables; second: the current drop in oil prices that threatens to erode the profitability of the entire industry [45].

At the same time, the debate on climate change has thus far paid little attention to NOCs, despite their importance in the present-day oil world emphasised above. By the same token, they themselves have not been particularly reactive to the challenges posed by climate change, since NOCs are subject to far fewer pressures than IOCs, the emerging 'pantomime villains' in the global climate discourse.

However, as a result of the Paris Agreement, the involvement of NOCs in climate change action is set to substantially increase. Under this agreement, countries voluntarily made emission reduction commitments (known as 'Nationally Determined Contributions' – NDCs) that generally entail ambitious regulatory and policy changes. It is likely that countries which have 'national champions' in the oil business delegate to them the bulk of the effort to reduce emissions since, being state-owned, this choice better testifies to the host countries' genuine involvement in the endeavour. NOCs, however, seem less prepared than IOCs to face the challenges posed by climate regulations and policy [27]. Whereas the latter have a wide range of options for decarbonising their business [62], NOCs seem to be facing a more limited menu, a more difficult one, because, as made clear by their ownership, shown in Table 1, these options would largely depend on governments [63] whose policies are likely to have a much broader focus than the individual NOCs [64]. NOCs' action against climate change could indeed be favoured by the Organization of the Petroleum Exporting Countries (OPEC), a permanent intergovernmental organisation of 14 oil-exporting countries founded in 1960, which coordinates and unifies the petroleum policies of its member countries (all of them have NOCs, some of which are among the largest in the oil and gas industry). The OPEC Secretary General, in a speech at the 2017 International Petroleum Week in London [65], reaffirmed his organisation's commitment to tackling global climate change, as demanded by the Paris Agreement, through support for a shift to renewables in its member countries and, therefore, NOCs. A further glimmer of hope on the capacity of NOCs to adapt their business to less carbon-intensive models is provided by the already mentioned membership of some of the largest NOCs (Statoil, Pemex, Petrobras, Saudi Aramco, China National Petroleum) in the 'Oil and Gas Climate Initiative'.

4. The oil and gas industry's direct contribution to climate change: greenhouse gas emissions

Among the facts that testify to the role that the oil and gas industry has played – and still plays – in climate change, the most important are i) the contribution in terms of GHG emissions generated by its oil-related activities, and ii) the intense and prolonged initiatives that certain members of the industry envisaged, funded, orchestrated, and put into practice for discussing and denying the climate crisis and its causes. This section analyses the first point; the following section will deal with the second.

Recent studies by Richard Heede and colleagues have focused on the contribution of the large carbon producers to global cumulative emissions of major GHGs, such as carbon dioxide and methane [66–68]. 'Carbon majors', as these studies term the big carbon business, are the world's largest public and private investor-owned, state-owned, and government-run oil and gas, coal, and cement producers. The most remarkable finding of Heede and colleagues is that 62% of the global industrial emissions of carbon dioxide and methane from 1751 to 2015 can be traced to the activities of 100 currently active carbon majors (41 public investor-owned companies; 16 private investor-owned; 36 state-

[4] ExxonMobil's role in climate denial was paramount, as underlined in the section on it. An excellent investigative journalism coverage of the conflictual relationship between the Texan giant and climate change is provided by InsideClimate News [49].

owned; and 7 government-run) and 8 non-extant ones.[5] Their data also demonstrates that, given the rapid global industrialisation of the last few decades, the 100 currently operating carbon majors have produced 71% of global industrial emissions since 1988.[6] Moreover, a study recently published [69] extends Heede's [66] original finding by linking carbon majors' fossil fuel-related activities to atmospheric carbon dioxide and methane concentrations, as well as to relevant climate impacts, namely the global mean surface temperature (GMST) and the global sea level *(GSL)*, the latter being one of the major consequences of climate change [7]. Strikingly, this study found that the historical (1880–2010) and recent (1980–2010) emissions of 90 major carbon producers resulted in '… ~57% of the observed rise in atmospheric CO_2, ~42–50% of the rise in GMST and ~26–32% of GSL rise over the historical period of 1880–2010 and ~43% (atmospheric CO_2), ~29–35% (GMST), and ~11-14% (GSL) since 1980′ ([69]: 579). Importantly, carbon majors have produced more than half of their emissions in the past 25 years, when, as said, the global community was already well aware of the potential dangers of climate change.[7]

With specific regard to oil and gas companies, their contribution to global GHG emissions is, in many respects, impressive. The top 10 companies in terms of cumulative emissions of Heede's [66] study all belong to the oil and gas industry. The biggest 60 oil and gas companies contributed to more than 40% of global cumulative industrial emissions in the period 1988–2015; the top 10 accounted for almost 22%, and the top 20 companies for more than 30%, as evinced by Table 5.[8] The oil and gas industry holds fossil fuel reserves that, if burned, would bring the planet well above the 2 °C warming target: in order to avert exceeding that threshold, more than one third of current oil reserves and half of gas reserves should, in fact, be kept in the ground [73]

These figures and considerations give an idea of the salience of GHG emissions by oil and gas companies in climate change. A fundamental clarification is in order here: by indiscriminately providing their products to the global economy, oil and gas companies are the heartbeat of the current carbon-intensive socio-economic system. Their prominent role in the climate crisis and the important implications for climate change and the sustainability discourse should place these companies at the centre of the climate debate as primary agents of climate policy. By and large, states are, in fact, the principal agents involved in addressing climate change. Other stakeholders, such as civil society, individuals, private sector actors, local authorities and communities, and international institutions are considered secondary agents. While all stakeholders are to a different extent involved in the global efforts to combat climate change, oil and gas companies are, in relation to their actual prominence, the truly neglected agent in the current global climate discourse. Considering how strongly these particular corporate entities are implicated in contributing to and perpetuating the climate crisis, it is inacceptable to equate their position with that of the business world in general or, indeed, of other stakeholders. Oil and gas companies have a very distinctive, specific, and crucial role in the climate issue; despite their substantial contribution to this problem, their power and wealth, the benefits they derive from their fossil fuel-related activity, and their technical expertise, these companies are generally considered only as secondary agents in global climate governance. They are subject to the binding emission limits imposed on them by the national and subnational political authorities. At best, similarly to other corporations outside the carbon business, oil and gas companies assume voluntary obligations to disclose their GHG emissions and to integrate effective abatement strategies into their business models.[9] Given the nature of their core business, this is not enough. The oil and gas industry is causing, shaping, advancing, and defending the current unsustainable fossil fuel-dependent global economy. It has, in fact, played a unique role in the present socio-economic system, through which it has been dictating the rules of the game in terms of the global economy's reliance on oil. Through their informed and self-advantageous choice to continue the exploration, production, refinement, and distribution of oil and gas after the 1990s, and to deny the harmfulness of such products, these companies have imposed this reliance on fossil fuels on other industries, which have had to shape their business models accordingly, with a limited number of extremely costly alternative options; the same is true for individuals, who have had to adapt their lifestyles to Big Oil's business choices. Recognition of the prominent role of oil and gas companies in causing and perpetuating climate change should not be understood as a claim that they should become the only, or indeed the most important, agent. Different agents have different roles and

Table 5
Oil and gas companies' scope 1 + 3 greenhouse gas emissions 1988–2015, $GtCO_2e$ and % of global industrial emissions.1988–2015.
Source: Elaboration from The Carbon Majors Database – 2017 Dataset Release. According to the Greenhouse Gas Protocol of the World Resources Institute (WRI), scope 1 emissions refer to direct oil and gas combustions; scope 3 emissions originate from the downstream combustion (for energy and non-energy purposes) of oil and gas that they have distributed within the global economic system. Indeed, the largest share (roughly 90%) of oil companies' emissions consists of scope 3 emissions.

Oil and gas company	Emissions	Percentage	Typology
Saudi Aramco	40.6	4.5%	NOC
Gazprom (Russia)	35.2	3.9%	NOC
National Iranian Oil	20.5	2.3%	NOC
ExxonMobil (United States)	17.8	2.0%	IOC
Pemex (Mexico)	16.8	1.9%	NOC
Royal Dutch Shell (United Kingdom/Netherlands)	15.0	1.7%	IOC
China National Petroleum	14.0	1.6%	NOC
BP (United Kingdom)	13.8	1.5%	IOC
Chevron (United States)	11.8	1.3%	IOC
PDVSA	11.0	1.2%	NOC
Abu Dhabi National Oil	10.8	1.2%	NOC
Sonatrach (Algeria)	9.0	1.0%	NOC
Kuwait Petroleum	9.0	1.0%	NOC
Total (France)	8.5	0.9%	IOC
ConocoPhillips (United States)	7.5	0.8%	IOC
Petrobras (Brazil)	6.9	0.8%	NOC
Lukoil (Russia)	6.7	0.8%	IOC
Nigerian National Petroleum Corp	6.5	0.7%	NOC
Petronas (Malaysia)	6.2	0.7%	NOC
Rosneft (Russia)	5.9	0.7%	NOC
TOTAL 20 (Top 10)	273.6 (196.6)	30.4% (21.9%)	

[5] The emissions traced to carbon majors are calculated based on the carbon content of fuels marketed (subtracting non-energy uses), carbon dioxide from cement production process, carbon dioxide from flaring, venting, own fuel use, and fugitive or vented methane.

[6] According to Heede's figures, the top emitters and the vast majority of producers are fossil fuel corporations (oil and gas, and coal companies), whereas cement producers are a small minority among carbon majors. The original 2014 database, for instance, included only seven cement producers whose emissions amounted to 1.45% of carbon majors cumulative total ([21]: Table 4, 17).

[7] 833 Gt of carbon dioxide (50.4%) of the emissions associated with carbon majors' activities have been produced since 1988, whereas 820 (49.6%) were produced in the period between 1750 and 1987 ([70]:7). More generally, Heede ([66]: 234) claims that '[O]f the emissions traced to carbon major fossil fuel and cement production, half has been emitted since 1986.'.

[8] To be noted is that a very recent study [71] shows that methane – a GHG 84 times more powerful in warming the atmosphere than carbon dioxide over a 20-year time horizon – emissions from the fossil fuel industry could exceed those reported in Heede's (2014) study. The United States' methane emissions, for instance, could be as much as double the United States government's inventory [72]. Unfortunately, it is not possible here to disaggregate the specific contribution of the oil and gas industry.

[9] This is, for instance, the case of the 'Carbon Disclosure Project'. Or, in the case of methane emissions, of The Climate and Clean Air Coalition's 'Oil & Gas Methane Partnership'.

responsibilities in addressing climate change. Crucially, for instance, states should provide the appropriate legislative and political frameworks for ensuring that oil and gas companies act in accordance with their responsibilities and comply with their duties and obligations. Thus, it is not the intent of this article to obscure the role or importance of other agents; rather, it is the article's purpose to draw attention to a significant and utterly neglected group of agents, whose unique and distinctive role and responsibility in relation to climate change should be translated into much needed policies to support current climate efforts. Oil and gas companies should play their part in the emerging context of hybrid multilateralism [74], which is adequate and appropriate to their role in climate change, along with states, individuals, and other agents.

In sum, at this stage, fossil fuels should be considered a harmful product, the use of which is affecting health, lives, and the wellbeing of present generations of both humans and non-humans, and will continue to do so in the future [66]. As was the case with businesses dealing with products like tobacco, asbestos, and lead – once admissible but later blacklisted on the basis of sound scientific evidence on their harmfulness – it is time to acknowledge the role of the oil and gas industry and the moral and political implications deriving from its involvement in operating such harmful products.

5. Denial: an indirect contribution by certain major oil and gas companies to climate change

Science is complex and cautious, and the abstractedness and remoteness in time and space of climate science can exacerbate its comprehension amongst the general public. The results of science are, by definition, always uncertain: unfortunately, the public by and large has not much tolerance for uncertainty [75]. The former head of NASA's Goddard Institute for Space Studies James Hansen – among the world's leading climate scientists and one of the media's foremost go-to people for the expert's perspective on the issue – admits that climate scientists have largely failed in mobilising the public, let alone in engaging politicians, to act on climate change predictions that they have been making since the 1980s; nor have they succeeded in lessening a general aversion to uncertainty in relation to climate change [76,77]. Climate deniers have taken advantage of this failure, using it to assert that there is no agreement on the basic elements of anthropogenic climate change, and to deny it altogether [78], despite the almost unanimous scientific consensus [5,6].

Much ink has already been spilled on climate change denial.[10] However, any inquiry into the connection between the oil and gas industry and climate change cannot afford to ignore it – despite the 'Americanness' of the issue.[11] Not least because climate denial, albeit largely US-based and for obvious reasons limited to IOCs,[12] has meant successful lobbying against climate policy and regulations, with serious international repercussions, such as for instance ExxonMobil's effective efforts against the United States' ratification of the Kyoto Protocol.[13]

A handful of IOCs, with the not impartial acquiescence of the rest of the oil and gas companies (including NOCs), conceived and deployed climate denial. Denial has corrupted the dynamics of the entire oil world and paralysed global climate policy for decades [9]. As such, denial is a further, if indirect, contribution made by the oil industry to climate change.

Some major IOCs, through their skilful lobbying favoured by the denial and doubt that they have sowed,[14] have induced governments to commit a 'sin of omission', i.e. prevented engagement in promoting regulations for limiting GHG emissions [85], a behaviour that has markedly slowed global action against climate change and thus seriously aggravated its dire impacts.

Climate denial is particularly interesting in this context for two intertwined reasons: Exxon (since 1999, ExxonMobil) [35][15] and a recent tightening of ideological polarisation on climate change, largely fuelled by oil companies continuing denial funding [87,88].

Science shapes and drives policy, or at least it should. Scientific evidence should lend urgency and spur action. Major oil and gas companies have always known this, and some of them have therefore tried to corrode climate science to hinder climate policy progress. This is, at root, the rationale for 'traditional' climate change denial. Organisations funded, largely, by certain IOCs, and in particular by ExxonMobil, have played a fundamental role in climate denial [2,79,86,89–91].

ExxonMobil has orchestrated and financed the most sophisticated and successful denial campaign since the notorious tobacco industry one, the very same one the Texan oil giant to look to borrow logic, tactics, and even some of the talented spin doctors to sow doubt about climate change [78,92]. As said, while ExxonMobil's scientists were contributing to advancing climate science, the company was misleading its stakeholders by spreading doubt about it in its public communications [57].

When governments started in earnest to negotiate a global climate deal in the early 1990s, Exxon was at the forefront in funding a number of organisations critical of the Kyoto Protocol whose objective was to sway public opinion on the already established scientific consensus on the causality nexus between fossil fuels and anthropogenic climate change. Among these early organisations, the most influential were the already mentioned 'Global Climate Coalition', the 'Climate Council', and the 'Information Council on the Environment'. Exxon also funded the influential Washington-based 'George Marshall Institute', a think tank established by prominent scientists to defend the United States President Ronald Reagan's Strategic Defense Initiative (known as Star Wars); in 1988 the think tank turned its attention to the science behind global warming [75,77,78].

But, despite its 2007 internal acknowledgement of climate change and contextual assurance of discontinuing 'contributions to several public policy groups whose position on climate change could divert attention from the important discussion' ([93]: 39), ExxonMobil persisted in supporting organisations spreading climate science denial.[16]

[10] Most of the arguments on climate change denial have been masterfully analysed in the book *Merchants of Doubt* [9].

[11] Such 'Americanness' results from the greater availability of public information regarding engagement in denial efforts, – as well as regarding industry research activities – in the United States. In any case, denial went global (Australia, New Zealand, the United Kingdom, Eastern Europe) only after 2010 [79]. It is worth noting that a similar investigative work on denial at the European level, though on a much smaller scale, was carried out by the Corporate Europe Observatory (CEO). Their analysis [80], for example, described how BP until at least 2009 directly funded the Institute of Economic Affairs (IEA), a London-based radical 'free market' think tank, for researching climate change.

[12] By and large NOCs did not need to engage in denial, given their ownership structure, scope, and objectives [81].

[13] Supran, in an interview given to the Los Angeles Times in August 2017 [82] about the paper he co-authored on ExxonMobil's climate change communication [57], said that '[T]heir [ExxonMobil's] clear motivation was to undermine Kyoto'.

[14] For example, between 2000 and 2016 the fossil fuel industry spent over $2 billion to influence climate legislation in the United States Congress [83], a sum 10 times larger than that spent by environmental groups and renewable energy companies [84].

[15] This is not to say indeed that other IOCs (Chevron, ConocoPhillips, or, broadening the focus, the world's largest private coal company Peabody Energy, but also the European-based BP and Shell) did not take part in this charade: however, they have certainly played a lesser role than Exxon/ExxonMobil [35,57,86], which alone, for instance, disbursed $31 million in the period 1998-2014 for this cause, according to Greenpeace's website 'Exxonsecrets'.

[16] According to Frumhoff and Oreskes [94], other IOCs – BP, Chevron, Shell – are still funding, even if much less than ExxonMobil, climate denial organisations too, as well as United States policymakers like the notorious denialist senator James Inhofe. Interestingly, the DeSmog UK Greenwash database also shows that BP, Shell, ExxonMobil, Total, and Chevron in the two years 2016-17 funded more than 100 community activities, educational awards, and local events in the United Kingdom. Shell, for instance, has recently funded a new exhibition on electricity, part of the Manchester Science Festival [95].

Over the period 1998–2014, the company funded 69 climate denial organisations.[17] These organisations diligently sowed doubt among the public with some consolidated arguments implying that climate science is contradictory and scientists are divided, that most environmentalists are charlatans, and that actions to prevent climate change would be pointlessly endangering the global economy. Not surprisingly, ExxonMobil was also among the subjects that funded the 44 'free market', anti-government, climate-denying organisations that in early May 2017 wrote a letter to the United States President urging him to pull the country out of the Paris Agreement; on June 1 st of that year, President Trump announced the country's withdrawal from the Agreement.[18] The ambiguity of ExxonMobil is once again emphasised by its recent pronouncement that it will leave the American Legislative Exchange Council, a corporate lobby group engaged in preventing climate action, a decision already taken by other major IOCs, BP and Shell [98].[19]

Indeed, like the tobacco industry, on the public stage ExxonMobil funded established research institutions – e.g. Columbia University and the Massachusetts Institute of Technology (MIT) – for investigating science, policies, and technologies to address climate change, in order, some have stated [99], to publicly lend themselves a veil of concern. On the other hand, in a clandestine manner, it fostered uncertainty by raising doubts, even about indisputable climate science, confused the public by manoeuvring apparently independent research and policy institutions which misrepresented/cherry-picked peer-reviewed scientific findings to persuade the media of the contentiousness of climate science. It also slowed/stopped action with misleading claims about the need for 'sound science', and shaped government communication on climate change [86].

In sum, by funding a number of denial organisations that through their bogus science challenged the consensus, ExxonMobil helped to substantiate the impression that the reasons behind climate change were still largely uncertain. This manifestly undermined climate initiatives in the United States and, consequently, all over the world, exacerbating the gravity of climate threats. While the climate denial campaign seed was initially sown in the United States and only concerned an internal agenda, the roots of its arguments eventually spread to other countries, including the United Kingdom, Russia, Australia, and Canada.

To conclude this inevitably limited overview of ExxonMobil's climate deception with the words of David Kaiser and Lee Wasserman: 'a company as sophisticated and successful as Exxon would have needed to know the difference between its own propaganda and scientific reality' [100]. ExxonMobil chose not to openly disclose such truths, and it thus committed fraud that seriously, albeit indirectly, hampered the struggle against global climate change.

A second major, worryingly effective, consequence of some IOCs' funding of climate denial is the recent increasing polarisation of the climate discourse generated by the complex relationship between politics, science, and climate scientists [101,102]. In fact, climate denial is far from over; on the contrary, it is thriving [103].[20] Denial in recent years, still largely propelled by major IOCs [92], could further polarise the climate discourse by influencing the content of the denial themes and their prevalence over time [87,106].

Paradoxically, the indisputable climate consensus among scientists [5,6] has engendered a most intolerant scepticism among denialists. This scepticism can, in fact, be more properly defined as climate 'cynicism': doubts about the evidence of climate science have been skilfully replaced by doubts about the motives of the people who study climate change and communicate scientific findings. Cynicism is fuelled by the ease with which such doubts are sown. All it takes is time, money, and the right political context. ExxonMobil alone has 'invested' a great deal of money – more than $240 million – to foster new forms of denial in the last two decades [107]. At the same time, a political context able to politicise the scientific orthodoxy, not simply to dispute it, was carefully orchestrated with the money contributed by some IOCs [108]. With this money, the new denialists have been able to portray climate change as an issue created by climate scientists for climate scientists, as a fabrication to keep alive an obscure, yet sizeable, techno-scientific elite, as well as for the good of the notorious pro-big government and higher tax environmentalists [109]. IOCs' money and effort seems to have achieved its alleged goal: climate change has been polarised and turned into an emblem of the partisan divide and has thus been transformed into what is often perceived as merely a thorny political issue; its intractability, however, can seriously damage the planet and eventually disrupt human life.

6. Conclusion and possible developments

This article carried out a narrative review framing in factual terms the role of the oil and gas industry in climate change. The review first contextualised oil and gas companies within the climate challenge. It went on to offer insight into their awkward acknowledgement of climate change. Finally, the review focused on their contribution to the climate crisis through GHG emissions and denial.

By way of conclusion, it is worth noting that after the Paris Agreement, the oil and gas industry started contemplating a future world less swamped by fossil fuels, expressing a desire to be somehow part of that future, be it for sheer survival motives, or as a strategic option to reassure their shareholders, as even the oil *sanctum* – OPEC – made clear [65].

To this end, despite the persisting pessimism of some observers [110], the oil and gas industry must change, so it is worth briefly outlining, rather indicatively, possible future developments. These closing remarks are not the suitable setting for an examination of this complex evolution; rather they aim to suggest possible entry points for subsequent work on the moral and political implications for the oil and gas companies and for climate policy. Suffice it to say that the oil and gas industry needs to develop a vision for a transition to a low-carbon world in the near future if it still wants to be an active part of it [111]. This vision would be very likely based on three intertwined elements: energy efficiency, low carbon technologies, and technologies for carbon capture and storage supported by carbon pricing [45]. However, it is necessary to reiterate that the oil and gas industry must admit, perhaps in the first instance to itself, that the old world is unquestionably mutating, and that the new low-carbon world should not and will not forget its role in endangering the old one. This implies that the direct and indirect contributions that oil and gas companies made to climate

[17] These figures, as already emphasised, are reported by Greenpeace's website 'Exxonsecrets': this database uses data from the company's official documents (covering the years 1998-2014). Another source [96] extends the coverage of the same database to the period 1997–2015 and indicates that the funds disbursed by ExxonMobil amounted to almost $34 million.

[18] Besides ExxonMobil, the big funders of this constellation of deniers were the Mercer Family Foundations and the Koch brothers, which in the period 1997–2015 contributed altogether $23 million to the top ten signatories of the May 2017 letter [97].

[19] It is interesting to report a comment on this by the advocacy group 'Corporate Accountability': 'Exxon's departure from ALEC [American Legislative Exchange Council] is a clear indication that the Big Polluter is feeling the heat. Make no mistake, despite what it would have people believe, Exxon isn't changing, it's caving. People and environmental groups have for years put pressure on Exxon for its use of trade associations like ALEC to do its climate denial bidding. Its exit from ALEC is a clear indication that not even Exxon, one of the biggest funders of climate denial and corporate polluters in the world, is immune to public pressure' [98].

[20] Even the International Energy Agency (IEA) is, according to some observers [104,105], undermining efforts against climate change by indicating energy paths that are inconsistent with the Paris Agreement goals and rather hamper the transition from fossil fuels.

change spawned different responsibilities. These responsibilities, in turn, mean that these companies have duties, i.e. standards of behaviour inspired by principles of justice that involve a moral commitment for doing or not doing something. Whereas the transition to a low-carbon economy can be morally grounded in a duty of decarbonisation that can be met by pursuing the strategy indicated above, oil and gas companies have, at the same time, a broader duty to society, namely a duty to rectify their wrongful actions which resulted in negative climate impacts, if they are to retain their social license to operate [112]. The moral justification of oil and gas companies' duties could lead to the emergence of a social norm which would delegitimise their current fossil fuel-centred behaviour and make them more willing to accept the actions required in a new low-carbon world. An approach based on the oil and gas industry's responsibilities and duties can therefore usefully complement the legal strategy[21] currently underway in the USA, with New York City and twelve other cities and counties in the states of California, Colorado, Maryland, New York, and Washington, as well as the state of Rhode Island, currently seeking to shift part of the cost of protection from climate impacts to oil and gas companies [14,114]; or indeed political initiatives like California mayors calling for fossil fuel production in the state to end [115], or the National Inquiry on Climate Change (NICC) currently being conducted by the Philippines' Commission on Human Rights to investigate 47 major carbon producers for their alleged contribution to climate change and its impact on the human rights of the Filipino people [116].

A paradigm shift is underway and, to be a part of it, Big Oil must ensure it no longer abrogates its duties by contributing – under the essential stewardship of other stakeholders – to drawing up a concrete roadmap to illustrate change.

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